



INFLUENCE OF ACTIVE CARBON-ETHANOLAMINE POROUS LAYER SOLVATATION BY BENZENE ON ITS LUMINESCENCE

Maxim P Shabanov*, Aslan Yu Tsivadze., Alexander Ya Fridman., Elena M Morozova., Alexander K Novikov and Alexey A Averin

Institute of Physical Chemistry and Electrochemistry, Russian academy of sciences

ARTICLE INFO

Article History:

Received 7th December, 2017

Received in revised form 20th

January, 2018 Accepted 4th February, 2018

Published online 28th March, 2018

Key words:

solvatation, benzene, luminescence, layer, active carbon, ethanolamine derivatives, PVC.

ABSTRACT

The solvate of a layer with a limiting content of benzene and solvate with residual content of benzene were synthesized. This synthesis was conducted by means saturation with liquid benzene of the layer of active carbon with grafted ethanolamine PVC derivatives that are sewn to cellulose tissue and following evaporation to an undesorbable amount. It was established that the spectrum with a limited benzene content shows a change in the number and position of the bands as well as an increase in quantum yield. In saturated solvate bands are blurred into one wide band and luminescence extinction by approximately 75%. It is shown that the first case of wall solvation corresponds to the formation of host-guest complexes between cycles of ethanolamine derivatives of PVC and benzene molecules, as well as charge transfer complexes between aromatic wall structures and benzene molecules. In the second case, the limiting filling of the pores led to a structural deformation of the flat sections of the pores in the coal, which led to dilution of the bands and luminescence extinction.

Copyright©2018 Maxim P Shabanov et al. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

INTRODUCTION

A layer of active coal with grafted ethanolamine derivatives of PVC, sewn to cellulose tissue (hereinafter Sample I) is a sorption active luminescent substance [1,2]. This is due to the fact that groups of macromolecular cyclic ethanolamines and conjugated carbon structures are formed as a result of grafting. These carbon structures are linked by ether groups, that are analogous to the derivatives of anthracene, phenanthrene, pyrene, etc [3,4]. Activation of polyaromatic structures occurs by means of amino and hydroxy groups. Luminescent solvation leads to changes in the position, structure and intensity of bands in the luminescent spectra.

During the sorption of organic solvents, in particular benzene, pores of active carbon are filled through the pores of cyclic ethanolamine nets [2]. Consequently, solvate shells of polyaromatic structures walls in the carbon and pore walls of macromolecular cyclic ethanolamine probably can not be the same. When desorption at the temperature that is lower than benzene boiling point, some quantity of benzene vapor remains in pores [1]. It is possible that undesorbable benzene molecules when participating in formation of solvate shell of pore wall, can differently affect the state of electrons that are in groups through which excitation occurs and in polyaromatic structures that are responsible for emission.

This can lead to certain changes in position and shapes of luminescence bands. Saturation of pores with liquid benzene should not significantly affect the geometric structure of cyclic ethanolamines. Herewith benzene solvation of walls from polyaromatic structures can lead to different changes in luminescence spectrum that is depends on the shell size.

The purpose of the work is to synthesize a solvate with limiting content of benzene (hereinafter Sample I-L) and a solvate with residual benzene (hereinafter Sample I-R) by means of saturation the Sample I with liquid benzene and subsequent evaporation to its nondesorbable amount; to obtain luminescence spectra and investigate the effect of solvation on the spectra.

The literature does not provide with data of interest.

Experimental

The following objects were used in the work: bleached cotton medical gauze (Russia, GOST 9412-93); active carbon sol with sorbed PVC in a mixture of THF, benzyl alcohol and triethanolamine; monoethanolamine; benzene. Gauze was washed in solution based on complexones. Sol was prepared by grinding 8.75 g of active carbon of grade AR-1 in solution containing 10.5 g PVC of grade SG-7 with 12.2 % phthalic acid esters (China), 55 ml benzyl alcohol, 5.1 ml triethanolamine and 440 ml THF. Grinding continued until particle size established as 2.5-4.0 μm .

*Corresponding author: **Maxim P Shabanov**

Institute of Physical Chemistry and Electrochemistry, Russian academy of sciences

Samples luminescence spectra were registered on spectrofluorimeter «Fluorolog». Synthesis of Sample I was conducted accordingly to [1] by impregnating of gauze by sol. Further the sample was left in the air until THF was evaporized; it was heated at 105 °C. Then the sample was treated in 93% solution of monoethanolamine at 100 °C and washed in boiling water. Finally it was dried at 110°C.

Sample I composition: $\omega(\text{gauze}) = 86.8\%$, $\omega(\text{layer}) = 13.2\%$. The layer contains $\omega(\text{carbon}) = 48.2\%$ of active carbon. Luminescence spectrum (Fig. 1) shows complex band with a maximum at 410 nm and two arms at 430 and 470 nm.

The synthesis of samples I-L and I-R was carried out as follows. The initial Sample I was placed in a vessel with benzene and pressed repeatedly until the air was removed. Some samples were placed in a graduated cylinder and the volume was measured, and others were kept in the air flow to a constant mass.

Benzene content and partial volume in Sample I-L as well as undesorbable benzene content in Sample I-R were calculated by the following formulas.

$$C(\text{benzene I-L}) = (m_2 - m_1) / (0.01 * \omega(\text{layer}) * m_1 * M) \quad (1)$$

$$V_{\text{partial}} = 100(m_2 - m_1) \rho^{-1}(\text{benzene}) / (V - 0.01 \omega(\text{gauze}) m_1 \rho^{-1}(\text{cellulose})) \quad (2)$$

$$C(\text{benzene I-R}) = (m_3 - m_1) / (0.01 * \omega(\text{layer}) * m_1 * M) \quad (3)$$

where:

m_1 — sample mass before impregnation;

m_2 — sample mass after impregnation;

m_3 — sample mass after air flow procedure;

M — benzene molar mass;

V — volume of impregnated sample;

$\rho(\text{cellulose}) = 1.55 \text{ g/ml}$.

Sample I-L and Sample I-R spectra are shown in Fig. 1.

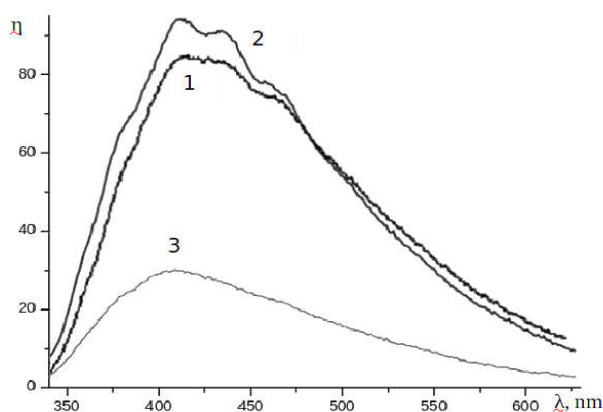


Figure 1 Luminescence spectra. 1 – Sample I; 2 – Sample I-L; 3 – Sample I-R.

RESULTS AND DISCUSSION

Relying on formulas given above following data were obtained. $C(\text{benzene I-R}) = 0.22 \text{ mmol/g}$, $C(\text{benzene I-L}) = 28.8 \text{ mmol/g}$, $V_{\text{partial}} = 94.6\%$. I-R and I-L samples spectra strongly differ from the spectrum of Sample I. It indicates the effect of pore solvation on the layer luminescence. Spectrum I-R includes three bands with maxima of about 415 nm, 440 nm and 462 nm, and arm at 380-385 nm. The quantum yield increased by 10-12%. Spectrum I-L has wide band with maximum at above 412 nm. Luminescence extinction is

approximately 75%. Consequently pore walls solvation leads to changes in luminescence spectrum.

It seemed reasonable to reveal differences in solvation of wall pores by nondesorbable benzene and benzene that almost completely fills pores for explanation of this phenomena.

According to [1], Sample I has specific surface area of 625 m^2/g (BET method). Using this value and the values of $C(\text{benzene I-L})$ and effective (incompressible) radius of benzene molecules, the average number of benzene molecules on the effective surface was calculated: $\bar{n} \approx 1.48$. Consequently walls of some pores are covered by a monomolecular layer, and other ones by a layer of several benzene molecules. According to [2] the value of $S(\text{BET})$ is close to an additive value of constituent parts of the layer. Active carbon accounts of about 70% of developed surface. According to [5], the structural elements of macromolecular cyclic N-ethanolamines bind benzene molecules to host-guest complexes. Then the change in the structure of 400-500 nm band and the emergence of the arm in short-wave part can be explained by the fact that Sample I-R wall solvation corresponds to the formation of both mentioned complexes and complexes with charge transfer between aromatic structures of walls and benzene molecules.

CONCLUSIONS

According to [3,4] solvation of organic luminescents (derivatives of polyaromatic hydrocarbons) in solutions leads to internal extinction of luminescence. It occurs due to distortion of plane structure of conjugated structures. Judging from the value of the benzene partial volume in Sample I-R, its pore walls are fully covered with monomolecular layer. Apparently, under this influence some deformation of plane areas occurred, which led to blurring of bands and extinction of the luminescence.

References

1. Tsivadze A. Yu., Fridman A. Ya., Morozova E.M., Sokolova N.P., Voloshchuk A.M., Petuhova G.A., Gorbunov A.M., Novikov A.K., Polyakova I. Ya., Bardyshev I.I., Averin A.A. Sorbent iz poristoy tkany na osnove tsellulosi i sloya iz soyedinenij aktivnogo uglya s etanolotsiklaminny proizvodnimi PVKh (Sorbent from porous tissue based on cellulose and the layer of active carbon compounds with ethanolamine derivatives of PVC). Matters of III All-Russian conference with international participation «Actual adsorption problems». 2016, Moscow. P. 91.
2. Tsivadze A. Yu., Fridman A. Ya., Shabanov M. P., Morozova E. M., Sokolova N. P., Petuhova G. A., Gorbunov A. M., Novikov A. K., Polyakova I. Ya., Bardyshev I. I., Averin A. A. Sloi iz aktivnogo uglya s ptivitimy etanolaminovimi proizvodnimi PVKh (Layers from active carbon with grafted ethanolamine derivatives of PVC). XVI All-Russian symposium with international participation «Actual problems of adsorption, porosity and adsorption selectivity theory». 2016, Moscow-Klyazma. P. 75
3. Krasovitsky B. M., Bolotin B. M. Organicheskiye luminofory (Organic luminofors). 1984, Moscow. P. 336.

4. Turner B. L., Frossard E., Baldwin D. S. Organic Phosphorus in the Environment. CAB books CABI Pub., 2005. P. 399.
5. Fridman A. Ya., Tsivadze A. Yu., Morozova E.M. Prevrashchenie poverhnostnyh sloev PVKh v izoliruyushchie sloi makromolekulyarnyh ciklamov - novoe napralenie v oblasti himicheskogo kapsulirovaniya. Obzor (The transformation of PVC surface layers into insulating layers of macromolecular cyclic amines - new direction in the chemistry capsulation field. Review). Protection of Metals and Physical Chemistry of Surfaces. 2015. V. 51. № 6. PP. 635-655.

How to cite this article:

Maxim P Shabanov *et al* (2018) 'Influence of Active Carbon-Ethanolamine Porous Layer Solvation by Benzene on its Luminescence', *International Journal of Current Advanced Research*, 07(3), pp. 11031-11033.
DOI: <http://dx.doi.org/10.24327/ijcar.2018.11033.1899>
